AECOM Environment

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Toms River, NJ

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March 2014

Corrective Measures Study Work Plan
BASF Corporation

Former Ciba-Geigy Site
Cranston, Rhode Island

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List of Acronyms

AOC	Area of Concern
COCs	Contaminants of Concern
CMS	Corrective Measures Study
VOCs	Volatile Organic Compounds
DEC	Direct Exposure Criteria
ELUR	Environmental Land Usage Restriction
I/C DEC	Industrial/Commercial Direct Exposure Criteria
ISCO	In Situ Chemical Oxidation
ISCR	In Situ Chemical Reduction
MNA	Monitored Natural Attenuation
MPS	Media Protection Standards
PHERE	Public Health and Environmental Risk Evaluation
RCRA	Resource Conservation and Recovery Act
RIDEM	Rhode Island Department of Environmental Management
R DEC	Residential Direct Exposure Criteria
RFI	RCRA Facility Investigation
SVE	Soil Vapor Extraction
SWMU	Solid Waste Management Unit
USEPA	United States Environmental Protection Agency
WWTA	Waste Water Treatment Area

1.0 Introduction

This Corrective Measures Study (CMS) Work Plan has been prepared for BASF Corporation's (BASF's) former Ciba-Geigy facility located on Mill Street and the separate Wastewater Treatment Area property formerly used to service the Mill Street facility, both located in Cranston, Rhode Island. The purpose of the CMS Work Plan is to identify applicable regulatory criteria to serve as remediation goals and to identify remediation technologies to achieve those goals for impacted media.

A RCRA Administrative Order of Consent (AOC) between Ciba-Geigy and the EPA was signed in June 1989, and it identified the stages for RCRA corrective action: a facility assessment and investigation and a corrective measures study and report. A modification to the Consent Order was finalized in 1992. The modification described stabilization measures for Production Area soil, groundwater, interim remedial measures (IRM) work plans, conceptual design, and operation and maintenance plans. It also specified that the Phase II activities for the Pawtuxet River area commence.

The regulated areas can be separated into three properties (Figure 1): the Production Area, the Waste Water Treatment Area (WWTA) and the Bellefont Property. In 1995 the Bellefont property was identified as an area of concern (AOC), and the EPA deferred this AOC to RIDEM for investigation and remediation under its Remediation Regulations. The WWTA property was sold in 2004, however, to date the EPA has not issued a Statement of Basis, and as such it remains part of this CMS. The Production Area is currently owned by BASF. It was the subject of several interim remedial measures during the 1990s, and the remedial goals and necessary remedial actions are included in this CMS.

The sediment of the Pawtuxet River associated with Production Area activities was described and characterized in a separate RCRA Facility Investigation (RFI) (Ciba, 1996). An Interim Remedial Measure (IRM) was completed and impacted sediment was removed from the former coffer dam area within the river and disposed off-Site in 1996. A sand cap was emplaced at the conclusion of the IRM excavation and has been periodically monitored since that time to ensure that it is competent.

Table 1 provides a list of the documents that, in addition to data currently being collected to further characterize soil and groundwater impacts, provide the basis for developing the CMS.

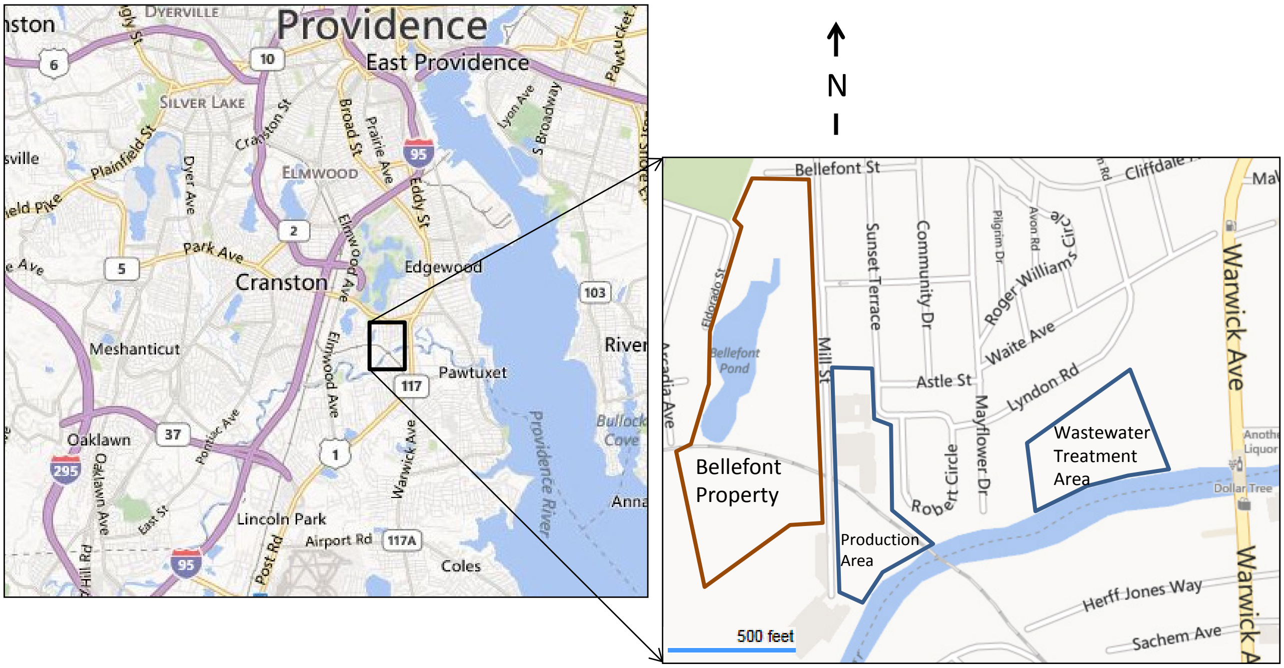

Figure 1: Parcels Associated with the Former Ciba-Geigy facility. The parcels that are covered under this CMS are the Production Area and the WWTA. The Bellefont property is being addressed under a separate order with the RIDEM.

1.1 Site Overview

The Former Ciba-Geigy facility was a chemical manufacturing facility operated by Alrose Chemical Company beginning in 1930. It consists of the Production Area and the WWTA (Figure 2).

The Geigy Chemical Company of New York purchased the facility in 1954 and later merged with the Ciba Corporation in 1970. The Production Area was used for batch manufacturing of organic chemicals, such as plastic additives, optical brighteners, pharmaceuticals, and textile auxiliaries (Ciba, 1995). Ciba-Geigy ceased all chemical manufacturing operations in May 1986 when the plant was closed and in 1986 the production facility was demolished to grade, where building foundations and subsurface structures were left in place. A detailed history of the Site, Site use, and an overview of applicable regulatory drivers and requirements were provided in the Phase II RCRA Facility Investigation (RFI) (Ciba-Geigy Corporation, 1995). Additional characterization of groundwater and soil and an updated conceptual site model at the Site was completed and presented in the Supplemental Remedial Investigation Report (AECOM, 2012).

Numerous historical environmental investigation and remediation projects have been performed at the Production Area and WWTA over the last 30 years. These activities were performed by multiple sub-contractors and environmental consultants. The Phase I RFI Interim Report was completed in 1991 and the Phase II RFI completed in 1995 (Ciba Corporation, 1995), which provided the initial site-wide characterization of environmental conditions at the Site. Many environmental investigations and several targeted remediation projects were performed at the Production Area and associated Pawtuxet River sediment and WWTA during the 1990s and 2000s.

- Production Area investigations are described in the Supplemental Remedial Investigation Report (AECOM, 2012).
- The Phase II RFI (Ciba, July 31, 1995) included source characterization, soil and groundwater characterization, fate and transport and risk evaluation for each of the Production and Waste Water Treatment Areas.
- The Pawtuxet River RFI (Ciba, March 31, 1996) included physical characterization, source characterization, release characterization, and river modeling investigations as well as a Baseline Ecological Risk Assessment.
- Remediation activities for the Production Area soil, groundwater, and sediment are described in the On-Site Corrective Measures Study (Woodward-Clyde, 1995), On-Site Soil IRM (Woodward-Clyde, 1996), Sediment IRM for the Pawtuxet River (Woodward-Clyde, 1996), and the Sediment IRM Report (AECOM, 2012).

This CMS Work Plan includes the regulatory requirements and current status of: (1) Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs) at the Production Area; (2) the WWTA; and (3) the Pawtuxet River sediment.

Based on review of the historical documentation referenced above (1991 through 2012) and ongoing data collection field work, the Production Area is characterized as having two primary subsurface impacts that need to be addressed in this CMS: residual polychlorinated biphenyl (PCB) impacts in subsurface soils and residual volatile organic compound (VOC) impacts in subsurface soil and groundwater. **Figure 3** presents the PCB soil impacts, and **Figure 4** presents the groundwater VOC impacts.

Characterization of the WWTA was completed during the 1991 and 1995 RFIs, and based on a risk evaluation at the time (Phase II RFI, 1995), it was concluded that, while there were sporadic detections of two SVOCs, a pesticide (chlordane) and arsenic in soil, there was no unacceptable risk associated with the compounds in the soils because risk was within the EPA target risk range of 1 x 10^{-4} and 1 x 10^{-6}.

1.2 Regulatory History and Current Status

As with many other industrial facilities with long operational histories, contaminants of concern (COCs) have been identified at the Production Area and WWTA. Some of these COCs eventually migrated to groundwater at the Production Area and were found in sediment adjacent to the Production Area. Since environmental investigation and remediation activities began in the early 1990s, the two properties have been subject to regulatory orders and a number of compliance measures dictated by applicable regulations, including:

- USEPA Consent Order RCRA No. I-88-1088 (1989); and
- USEPA Consent Order Modification to RCRA No. I-88-1088 (1992).

Investigation and remediation work required by the consent orders has been performed under USEPA oversight to move the properties toward final compliance under RCRA Corrective Action. In 1995, the Bellefont property was identified as an area of concern (AOC), and the EPA deferred this AOC to RIDEM for investigation and remediation under its Remediation Regulations. The WWTA property was sold in 2004, however, to date the EPA has not issued a Statement of Basis and as such it remains part of this CMS.

A Phase II RFI was completed and documented in a report to USEPA (Ciba, 1995). A Public Health and Environmental Risk Evaluation (PHERE) was completed as part of the RFI, per the Order (EPA, 1989). The PHERE evaluated potential human health and ecological risks associated with each operational area. For the Production Area unacceptable human health and ecological risks were identified primarily from PCB and VOC impacts in soil, groundwater and sediment. To mitigate these impacts and provide a basis for necessary Interim Remedial Measures (IRM), site-specific Media Protection Standards were developed. The IRMs were developed and implemented in 1995 and 1996 for soil (PCB excavation and capping and soil stabilization via the installation and operation of a soil vapor extraction system [SVE]), groundwater (installation and operation of a groundwater pumping and treatment system [P&T]) and sediment (excavation and capping). The SVE system was operated from 2000 to 2005, when, based on the conditions that it had reached its asymptotic end point and post-operation verification sampling showed that the MPS was achieved, it was determined that the system had addressed the soil impacts. The P&T operated from 1996 to 2006 when performance monitoring showed that the MPS had been achieved. Continued monitoring showed a rebound in concentrations in the southeast corner of the property in 2008, and this triggered a remedial investigation to delineate the recalcitrant zone, and remediation of this zone is in part the subject of this CMS.

With regard to the WWTA, the RFI risk evaluation concluded that risk associated with site-related soil and groundwater impacts met the conditions for unrestricted future use. Groundwater did not exceed any applicable risk-based standard. For soil, this conclusion was based on the risk calculation result that the hazard index (HI) for non-cancer compounds was less than 1 (actual HI = 0.4), and the total lifetime cancer risk was 3 x 10^{-5}, which is within the EPA target risk range of 1 x 10^{-4} and 1 x 10^{-6}. The soil risk was dominated by a site-related furan. Given the conclusions of the risk evaluation no IRMs were required for the WWTA.

Since the RFI, a significant amount of field work has been, and continues to be, implemented on the Production area. Based on the findings of the Supplemental Remedial Investigation (AECOM, 2012), subsurface soil and site-related groundwater at the Production Area property were found to require remedial action over and above the IRM measures previously applied. Specifically, this characterization shows that subsurface soils contain PCBs above current remediation standards, and there is a localized groundwater zone that is impacted with site COCs above the MPS. Additional soil and groundwater sampling data is being collected to fully delineate remaining impacts at the Production Area property. These data will be incorporated into the CMS and the remedial alternatives evaluation.

With regard to the Pawtuxet river sediments, a Phase II RFI was completed by Ciba-Geigy in 1996. The RFI concluded that excavation, disposal, and capping of impacted sediment from the former cofferdam area in the river adjacent to the Production Area would significantly reduce the concentrations of Site COCs in river sediment. This assessment provided the basis for a subsequent IRM to provide “significant, long-term reductions in contaminant concentrations” within the Upper Facility Reach of the Pawtuxet River, where over 2,225 tons of contaminated sediment was excavated and replaced with clean sand (Sediment IRM Pawtuxet River, 1996). Periodic sediment sampling conducted by Ciba verified the intent of the IRM. However, after a 500 year flood event in 2010 and following a request by the EPA, BASF monitored the sand cap emplaced over the former cofferdam area to confirm that the sand and witness barrier were still present (AECOM 2011). Additional sediment sampling immediately upstream and downstream of the capped area was also completed at that time. While the cap was shown to be intact and functioning as intended, sediment analytical results outside the capped area indicated that three discrete areas of sediment continued to contain residual PCB. In 2012, BASF voluntarily addressed these areas by excavation and capping with clean sand. A total of 23 CY of impacted sediments were removed from the Pawtuxet River and disposed off-site at appropriate facilities (AECOM 2011). Future sediment actions will consist of periodic monitoring of the sediment sand cap.

1.3 Site Specific Purpose of the CMS

The purpose of the CMS portion of the RCRA corrective action process is to identify and evaluate potential remedial technologies and alternatives for addressing hazardous constituents released to and contained in soil and groundwater that have been identified, as well as to specify long-term monitoring of engineered controls (i.e., periodic sediment cap monitoring). This is a focused CMS Work Plan, which evaluates remedial technologies that are appropriate for the properties based on implementability, site conditions, contaminant characteristics, and professional judgment and experience.

The CMS is designed to address the following objectives:

- Identify media-specific cleanup standards;
- Identify potential treatment technologies, containment/disposal, and institutional/engineering control options for impacted soil and groundwater;
- Perform technology screening;
- Assemble technologies into alternatives;
- Analyze the identified alternatives using specific evaluation criteria and cleanup standards;
- Compare alternatives against each other using the evaluation criteria; and

- Recommend remedial alternatives.

1.4 Report Organization

This CMS Work Plan is organized into seven sections. S**ection 1.0** presents the site description, regulatory history and current status, site-specific purpose of the CMS, and the report organization. **Section 2.0** presents a description of the corrective measures objectives. **Section 3.0** presents the corrective measures technologies to be evaluated. **Section 4.0** presents the remedial technology and remedial alternatives evaluation criteria. Potential bench-scale and pilot-scale testing for the site is introduced in **Section 5.0**. **Section 6.0** presents the outline for the CMS report, schedule, and project management report. **Section 7.0** presents the references used herein.

2.0 Corrective Measures Objectives

2.1 Target Media Cleanup Standards

The Rhode Island Remediation Regulations (Remediation Regulations) and Site-specific Media Protection Standards provide the applicable clean-up criteria for soil and groundwater at the properties under the RCRA Corrective Action program. The criteria to be applied for various media at the properties are discussed in the following sections and are presented on **Table 2**.

2.1.1 Soil

The Remediation Regulations contain numerical, default criteria used to determine the need for remediation of soil associated with a release area that are based on both the potential for human health impacts from direct exposure to contaminants in soil (direct exposure criteria) and on the potential for contaminants in the soil to have an adverse impact on groundwater (leachability). Two sets of direct exposure criteria are specified: one derived for residential land use, and the other derived for industrial and certain commercial land uses. Because groundwater is classified as GB, RIDEM leachability criteria for GB groundwater apply.

Soil sampling in the WWTA was evaluated in a risk assessment submitted to and reviewed by USEPA (RFI, 1995). The risk assessment concluded that compounds detected in soil posed no unacceptable risk for an unrestricted future site use because the risk was within the EPA target risk range of 1×10^{-4} and 1×10^{-6}. Therefore, soil criteria will not need to be considered for the WWTA. However, application of an ELUR at this property to restrict future residential use will be considered as a conservative measure to control potential risk. This property is zoned as commercial for office or neighborhood business (Cranston, RI Code of Ordinances, library.municode.com).

<u>Direct Exposure Criteria</u>

Industrial/Commercial Direct Exposure Criteria (I/C DEC) will be applied to the Production Area property, which is currently zoned industrial/commercial. Since the I/C DEC will be applied to the Production Area, an Environmental Land Usage Restriction (ELUR) must be executed to preclude future residential uses of the Production Area.

According to the Remediation Regulations, I/C DEC may be applied to “a depth of at least 2 feet below ground surface for each hazardous substance in soil if all of the following conditions are met:

a. The contaminated-site is currently limited to industrial/commercial activity;
b. Access to the property containing the contaminated-site is limited to individuals working at or temporarily visiting the subject parcel;
c. The current and reasonably foreseeable future human exposure to soils at the contaminated-site is not expected to occur beyond a depth of 2 feet below ground surface; and
d. An environmental land usage restriction consistent with Rule 8.09 (Institutional Controls) is in effect with respect to the property, or to the portion of the property containing the contaminated-site; such an environmental land usage restriction shall ensure that the property or restricted portion thereof is not used for any residential activity in the future and that any

future use of the property or restricted portion thereof is limited to industrial/ commercial activity", unless further cleanup or evaluation is performed to meet more stringent criteria for residential re-development.

These conditions will be incorporated into the CMS evaluation.

These criteria are for comparison to soil data analyzed as a ratio of mass of contaminant to mass of dry soil (typically micrograms per kilogram [µg/kg] or milligrams per kilogram [mg/kg]).

Leachability Criteria

Because the Production Area is located in a GB groundwater area, the GB leachability criteria, or equivalent as defined in the Remediation Regulations, apply.

Site-Specific Media Protection Standards (MPS)

Site-specific soil MPS were developed for the Production Area soil in the RFI (Ciba, 1995). A Public Health and Environmental Risk Evaluation (PHERE) was performed (Ciba Corporation, 1995), and no unacceptable human or ecological health risks were found for soils. While this was the case, the site-specific PCB MPS for the Production Area soil was set at 50 ppm based on consideration of an outdoor worker for an industrial or commercial land-use. The site-specific MPS is compared to current federal and state rules governing PCB cleanup. Specifically, under the Toxic Substance and Control Act (TSCA), 40 CFR 761.61(a)(4), less than or equal to 100 ppm PCBs may be left on-Site with a cap covering the Site along with a low-occupancy future Site use restriction. Alternately, removal of all PCBs in soil greater than 10 ppm and a cap over soil that contains greater than 1 ppm and less than 10 ppm PCBs would allow a high occupancy Site re-use. Rhode Island (RI) Industrial/Commercial Direct Exposure Criteria (I/C DEC) limit PCBs in soil to a maximum of 10 ppm, with a 2 ft soil cap.

2.1.2 Groundwater

The Remediation Regulations contain numerical, default criteria for contaminated groundwater associated with a release area. Criteria are established to protect groundwater and surface water resources, and to protect human health from contaminants that may volatilize from contaminated groundwater. Site-related groundwater is classified by the RIDEM as GB which not suitable for use as a current or potential source of drinking water. Additional information on groundwater criteria is presented in the following sections.

Groundwater sampling in the WWTA (RFI, 1995) was evaluated in a risk assessment, submitted and reviewed by USEPA. The risk assessment concluded that compounds detected in groundwater posed no risk for an unrestricted residential future site use. Therefore, groundwater criteria will not need to be considered for the WWTA.

GB Groundwater Objectives

The Remediation Regulations specify criteria for the protection of groundwater in a GB groundwater area. The GB Groundwater objectives will be applied to the Production Area property.

Site-Specific Media Protection Standards (MPS)

The Pawtuxet River Corrective Measures Study (Woodward-Clyde, 1996) presented proposed MPS for site-specific volatile organic compounds (VOCs) in groundwater at the Production Area property: toluene (1,700 ppb), 2-chlorotoluene (1,500 ppb), 1,2-dichlorobenzene (94 ppb), chlorobenzene (1,700 ppb), and total xylenes (38 ppb). The MPS for the Site COCs, except toluene, were based on benthic invertebrate Toxicity Reference Values (TRVs) and developed to be protective of benthic organisms as site-related groundwater discharges to the river. For toluene, the MPS was based on the RI GB Groundwater Objective because it was a lower value, and thus, more protective. The MPS for total xylenes was later corrected to 76 ppb in the April 1998 Groundwater Sampling Report submitted to EPA in August 1998. The report states that the revision, based on a mis-reporting of 38 ppb in the original PRCMS, was approved by USEPA. These proposed groundwater MPS will be applied to the Production Area property.

2.1.3 Sediment

As part of the Production Area IRM program implemented in the 1995 – 1996 time-frame, a voluntary sediment IRM was conducted, where over 2,225 tons of visually contaminated river sediment from the Former Cofferdam were excavated and replaced with a clean sand cap (Woodward-Clyde, 1996).

A major flooding event occurred during the spring of 2010, and at that time the EPA requested that BASF re-sample the sediment cap to ensure that it is functioning as intended. In 2011 BASF took samples of the capped area and found it to be functioning as intended with the coarse sand cap still in place (AECOM, 2011).

This media is included in the CMS in order to specify a periodic monitoring program for the emplaced sand cap in the Pawtuxet River.

2.2 Compliance Points

2.2.1 Soil

Soil remediation compliance points will be identified and included during the Corrective Measures Study.

2.2.2 Groundwater

Site-related groundwater from the Production Area eventually discharges to the Pawtuxet River. The MPS defined for the Production Area were derived to be protective of environmental receptors, in particular benthic organisms. Thus, the compliance points for groundwater associated with the Production Area will be located between the Site and the river. Based on where the groundwater plume is located as it migrates towards the Pawtuxet River, the proposed wells where compliance with the MPS is needed for the Production Area are listed in the following table and shown on Figures 4a and 4b:

Groundwater
MW-32S/D (Proposed)
MW-31S/31D
P-30D
MW-29D

2.2.3 Sediment

The sediment area that comprises the former cofferdam area, adjacent to the Production Area, will be addressed through periodic monitoring to confirm the presence of the IRM engineered control (i.e., sand cap).

3.0 Identification of Corrective Measures Technologies

An initial list of potential technologies was screened for impacted media at the Site (Table 3). Criteria used to screen technologies include site conditions, contaminant characteristics, and technology characteristics. A description of each criterion is provided.

- **Site conditions**: Site data should be reviewed to identify conditions that may limit or promote the use of certain technologies. Technologies whose use is clearly precluded by site characteristics are eliminated from further consideration.
- **Contaminant characteristics**: Identification of contaminant characteristics that limit the effectiveness or feasibility of technologies is an important part of the screening process. Technologies clearly limited by these contaminant characteristics are eliminated from consideration. Contaminant characteristics particularly affect the feasibility of in situ methods, direct treatment methods, and land disposal (on/off site).
- **Technology limitations**: During the screening process, the level of technology development, the performance record, and the inherent construction, operation, and maintenance limitations are identified for each technology considered. Technologies that are unreliable, perform poorly, or are not fully demonstrated for the Site conditions and COCs are eliminated in the screening process.

Technologies which are deemed impracticable for use at the Site based on site conditions and contaminant mixtures were not retained for further evaluation. The screening results are included in **Table 3**. The remediation technologies which will be considered in the CMS are outlined below.

3.1 Soil Remediation Technologies

3.1.1 Production Area

Soil in the Production Area contains elevated concentrations of total PCBs that exceed the RIDEM I/C DEC concentration of 10 mg/kg as well as isolated locations that exceed Toxic Substances Control Act (TSCA) limits and the site-specific MPS of 50 mg/kg. In addition sporadic detections of semi-volatile organic compounds (SVOCs) and VOCs at concentrations that exceed RIDEM I/C DEC are present. Remediation of impacted soil will be evaluated in the CMS. Alternatives under consideration are: No Action, Institutional and Engineering Controls, Environmental Land Usage Restrictions (ELUR), Engineered Control (Cap), Excavation and Off-Site Disposal. Combinations of these alternatives may be evaluated.

3.1.1.1 No Action

The no action technology serves as a baseline against which other corrective measure technologies can be compared. Under this alternative, no remedial action would be conducted. The contaminants are left in place without implementing any containment, removal, treatment, or other mitigating actions. The no action alternative would not include institutional or engineered controls to prevent access to surface or subsurface soils. No ongoing monitoring is included with this alternative.

3.1.1.2 Institutional and Engineering Controls

Institutional and engineering controls are used to reduce risk of human exposure and/or further impacts to the environment by restricting site use and/or rendering impacts inaccessible or environmentally isolated.

The existing engineering controls at the Production Area consist of perimeter fencing around the Site to prevent unauthorized access, and paved areas which inhibit direct contact with underlying soil.

3.1.1.3 Environmental Land Usage Restrictions (ELUR)

Institutional controls are means of enforcing a restriction on the Production Area that limits exposure to impacted materials and prevents actions that would interfere with the remedial program. The Production Area is zoned industrial/commercial and currently is idle. The Production Area will continue to meet the requirements of industrial-commercial land use in the future, and an ELUR limiting future use to industrial-commercial use will be recorded, unless further cleanup or evaluation is performed to meet more stringent criteria for residential re-development. There are three general types of ELURs for soil, which are described below:

- Limits future uses of the Production Area to industrial-commercial;
- Prohibits disturbance or exposure to inaccessible soils (e.g. impacted soil below an adequate separation layer); and
- Protects any engineered controls that prevent infiltration of water through impacted soil.
- Allows for Production Area access to implement required monitoring.

In many cases, the institutional controls are used in conjunction with a containment mechanism (e.g. capping/engineered control) to address applicable criteria.

3.1.1.4 Engineered Control (Cap)

An engineered control (cap) will be evaluated to prevent direct exposure to the contaminants and/or prevent migration of the contaminant. Engineered controls include containment technologies consisting of covers and/or impermeable liners. Implementation of this remedial approach requires:

- Assessment of hydrogeologic setting (e.g., proximity to wetlands and flood hazard areas);
- Permitting;
- ELUR;
- Long-term monitoring and inspection/maintenance plans; and
- Annual reporting.

Configurations of engineered controls utilizing covers and/or impermeable liners to address DEC exceedances will be evaluated for soil.

3.1.1.5 Excavation and Offsite Disposal, Containment or Reuse

Excavation of impacted soils will be evaluated to address I/C DEC exceedances in the Production Area for PCBs and SVOCs. Multiple options will be evaluated for addressing the excavated soil, including:

- Off-site disposal; and
- On-site consolidation/reuse beneath an engineered control.

Details on the layout, volumes, and construction will be determined as the CMS is developed.

3.1.2 Waste Water Treatment Area

The Waste Water Treatment Area (WWTA) was purchased by Ciba-Geigy from a landscaper and then used as a waste water treatment facility for the process water from the Production Area. In 2004, Ciba sold the property and its current use is a landscaping operation. The property is currently zoned for commercial use.

WWTA soil and groundwater were characterized in the RFI (Ciba, 1995) and the impacts were found to be within the EPA target risk range for unrestricted future use (see Section 1.2). While there are no compounds that exceed the RIDEM's GB groundwater criteria, there was one sample collected in 1995 that detected the pesticide gamma-chlordane in excess of the RIDEM I/C DEC. Specifically, chlordane was detected at an estimated value of 19 mg/kg which exceeds the RIDEM I/C DEC criteria of 4.4 mg/kg in one shallow soil location (B12B1, 0-2 feet below ground surface). While exceeding, this concentration is representative of less than the mean concentration range of residues (22 mg/kg - 2,540 mg/kg) that are around home foundations that were treated with chlordane as a pesticide (http://www.epa.gov/ttn/atw/hlthef/chlordan.html), and it is thus considered not site-related.

Based on the discussion above, the CMS report will evaluate the following alternatives for the WWTA: No Further Action and ELUR.

3.1.2.1 No Action

The no action technology serves as a baseline against which other corrective measure technologies can be compared. Under this alternative, no remedial action would be conducted. The contaminants are left in place without implementing any containment, removal, treatment, or other mitigating actions. In addition, the no action alternative would not include institutional or engineered controls to prevent access to surface or subsurface soils. Finally, no ongoing monitoring is included with this alternative.

3.1.2.2 ELUR

Institutional controls are means of enforcing a restriction on the WWTA that limits exposure to potentially impacted materials. The WWTA is zoned for commercial use and currently is used as a landscaping operation. The WWTA may continue to meet the requirements of industrial-commercial land use in the future, but the Site was sold in 2004 and BASF does not control future land use currently. An ELUR limiting future use to industrial-commercial only would be a conservative approach to prevent any unforeseen potential future risk, unless further evaluation and, if necessary, remediation is performed to meet more stringent criteria for residential re-development. There are three general types of ELURs for soil, which are described below:

- Limits future uses of the WWTA to industrial-commercial;
- Prohibits disturbance or exposure to inaccessible soils (e.g. impacted soil below an adequate separation layer); and
- Protects any engineered controls that prevent infiltration of water through impacted soil.

As needed, the first two institutional controls are used in conjunction with the third, a containment mechanism (e.g. capping/engineered control), to address applicable criteria. However, in this case, based on available data and risk analysis, an engineered control is not necessary and will not be considered.

3.2 Groundwater Remediation Technologies

The alternatives described in this section are applicable to Production Area groundwater.

Several technologies presented in the Stabilization Report (Woodward-Clyde, 1996) have already been constructed in the Production Area. These technologies include a soil vapor extraction (SVE) system, extraction wells (hydraulic control system), and technologies used to treat extracted groundwater. The SVE system was constructed, operated to treat a toluene spill; it was shut down in 2004. The groundwater extraction and treatment system operated from 1996 to 2010 when long-term monitoring data showed aquifer restoration complete except for a recalcitrant area that was the subject of extensive remedial investigation (AECOM, 2012), and it is the subject of this CMS.

3.2.1 No Action

No action provides a comparative baseline against which other corrective measure technologies can be compared. Under this alternative, no remedial action would be conducted. The contaminants are left in place without implementing any containment, removal, treatment, or other mitigating actions. All groundwater monitoring, groundwater extraction, and reporting activities would cease. Natural processes such as biodegradation, dilution, and attenuation would continue, but these processes would not be monitored.

3.2.2 Institutional and Engineering Controls

Institutional controls are a means of enforcing a restriction on the Site that limits exposure to impacted materials and prevents actions that would interfere with the remedial program. The Site is currently idle. The Site will continue to meet the requirements of industrial-commercial site use; however, an ELUR limiting future use to industrial-commercial use has not yet been recorded for the Site. An ELUR limiting site use to industrial-commercial is anticipated, unless further cleanup or evaluation is performed to meet more stringent criteria for residential re-development.

3.2.3 Monitored Natural Attenuation

Monitored Natural attenuation (MNA) is a technology that relies upon the reduction of contaminant concentrations in groundwater resulting from the combined effect of dispersion, diffusion, volatilization, sorption, abiotic degradation, and biodegradation. The combined effect of these processes results in a concentration reduction over space and time that will result in a restorative trend. MNA is a plausible corrective measure that also involves groundwater monitoring to confirm the effectiveness of the natural attenuation and to quantify the reductions. MNA may be incorporated as a component of the remedial approaches outlined below.

3.2.4 In Situ Treatment Technologies

The following in situ treatment technologies were retained during the screening process for impacted groundwater.

3.2.4.1 In Situ Enhanced Microbial Reduction

In situ enhanced microbial reduction of VOC-impacted groundwater may be performed using microbial-facilitated creation of aerobic and/or reducing conditions. The objective is to reduce source and plume contaminant mass by biotransforming the VOCs to non-toxic compounds. Bench scale tests and a pilot study may be warranted to optimize injection locations, rates, and types and volumes of amendments needed to treat the COCs.

3.2.4.2 In Situ Chemical Reduction

In situ chemical reduction (ISCR) remediates contaminants by incorporating them into oxidation/reduction reactions. Chemical compounds, such as zero valent iron, are injected into the aquifer to chemically reduce toxic substances in the source and plume. Bench scale tests and a pilot study may be warranted to optimize injection locations, rates, and types and volumes of ISCR compounds.

3.2.4.3 In Situ Chemical Oxidation

In situ chemical oxidation (ISCO) remediates contaminants by incorporating them into oxidation reactions. Chemical oxidants are injected into the aquifer, which chemically oxidize toxic substances in the source and plume. Bench scale tests and a pilot study may be warranted to optimize injection locations, rates, and types and volumes of ISCO compounds.

3.2.4.4 In Situ Permeable Reactive Barrier

An in situ permeable reactive barrier (PRB) may be installed using materials that create microbial or abiotic-facilitated aerobic and/or reducing conditions to treat groundwater in-situ as it passes through the barrier. The objective is to intercept and treat plume contaminant mass by transforming the VOCs to non-toxic compounds. Bench scale tests and a pilot study may be warranted to optimize and design the PRB.

3.2.4.5 Hydraulic Control System

From 1996 to 2008 Ciba operated a groundwater extraction and treatment system to hydraulically control, both horizontally and vertically, impacted groundwater and prevent off site migration of Production Area-related impacted groundwater. Extracted water was treated on the property and discharged to the municipal treatment works. This alternative will evaluate optimization of the existing system.

3.3 Sediment

Several technologies presented in the Stabilization Report (Woodward-Clyde, 1996) have already been constructed in the Production Area. The technologies that were identified to be protective of sediment and river quality include sediment excavation, disposal, capping, and extraction wells (hydraulic control system) for hydraulic control of on-site groundwater from migrating into the river. The groundwater extraction and treatment system operated from 1996 to 2010 when long-term monitoring data showed aquifer restoration was complete except for a recalcitrant area. The recalcitrant area was the subject of extensive remedial investigation (AECOM, 2012), and it is a subject of this CMS. With respect to sediment stabilization, the CMS will consider periodic sediment sand cap monitoring to confirm its integrity.

4.0 Technology Evaluation Approach

The procedure for selecting appropriate corrective measures for a site consists of the following: develop a list of remedial technologies for the media and constituent groups; screen the technologies; assemble remedial alternatives; and evaluate the alternatives. This section presents the approach that will be used to evaluate the remedial alternatives. At the conclusion of the detailed analysis of alternatives, preferred alternatives will be identified.

4.1 Remedial alternative evaluation

Technologies which pass the initial screening are subsequently used to develop remedial alternatives. In compliance with the RCRA requirements, each alternative will be evaluated according to the following standards:

- Overall protection of human health and the environment
- Attain media cleanup standards
- Control the sources of releases
- Comply with applicable standards for the management of wastes
- Other factors
  - Long-term reliability and effectiveness
  - Reduction in the toxicity, mobility, or volume of wastes
  - Short-term effectiveness
  - Implementability
  - Cost

Each of these evaluation factors is discussed briefly below.

4.1.1 Overall Protection of Human Health and the Environment

Corrective measures must be protective of human health and the environment. Alternatives may include those remedies that are needed to be protective of, but not directly related to, media cleanup, source area control, or management of contaminants. Each alternative will be assessed to determine whether it can (1) adequately protect human health and the environment, in both short- and long-term time frames, from unacceptable risks posed by hazardous substances, pollutants, or contaminants, and (2) eliminate, reduce, or control exposures to established cleanup levels.

4.1.2 Attain Media Cleanup Standards

Corrective measures will be evaluated as to: the effectiveness of attaining media cleanup goals, which were derived from existing state and federal regulations, established background values, or alternative risk-derived target cleanup levels. The media cleanup goals for an alternative often play a large role in determining the technical approaches of the alternative. In some cases, certain technical aspects of the alternative, such as the practical capabilities of technologies, may influence the media cleanup goals to be established. Each alternative will be assessed to determine whether it would attain the treatment goals and protection standards established for the site media.

4.1.3 Control the Sources of Releases

A critical objective of any alternative is to stop further environmental degradation by controlling or eliminating further releases that may pose a threat to human health and the environment. Unless source control measures are undertaken, efforts to clean up releases may be ineffective or, at best, will essentially involve a perpetual cleanup. Therefore, an effective source area control program is essential to ensure the long-term effectiveness and protectiveness of the corrective measure.

4.1.4 Comply with Applicable Standards for Management of Wastes

Each alternative will be assessed to determine how the specific remedial activities being conducted comply with the identified applicable state and federal regulations for management of wastes.

4.1.5 Other Factors

4.1.5.1 Long-Term Reliability and Effectiveness

Demonstrated and expected reliability is a way of assessing the risk and effect of failure. Considerations include whether the technology or a combination of technologies have been used effectively under analogous site conditions, whether failure of any one technology in the alternative would have an immediate impact on receptors, and whether the alternative would have the flexibility to deal with uncontrollable changes at the site (e.g., heavy rain storms, flooding, etc.). Most corrective measure technologies, with the exception of destruction, deteriorate with time. Often, deterioration can be slowed through proper system operation and maintenance (O&M), but the technology eventually may require replacement.

Each corrective measures alternative will be evaluated in terms of the projected useful life of the overall alternative and its component technologies. Useful life is defined as the length of time the level of effectiveness can be maintained. In addition, each alternative will be assessed for the long-term effectiveness and performance it affords, along with the degree of certainty that the alternative will prove successful.

4.1.5.2 Reduction of Toxicity, Mobility, or Volume of Wastes

As a general goal, alternatives are preferred that employ technologies that are capable of eliminating waste or substantially reducing the inherent potential for on-site waste to cause future environmental releases or other risks to human health and the environment. There may be some situations where achieving substantial reductions in toxicity, mobility, or volume may not be practical or even desirable. Estimates of how much the corrective measures action will reduce the waste toxicity, volume, and/or mobility are beneficial in applying this factor. The degree to which each alternative employs recycling or treatment that reduces toxicity, mobility, or volume will be assessed, including how treatment is used to address the principle threat posed by soil and groundwater.

4.1.5.3 Short-Term Effectiveness

Short-term effectiveness is relevant when corrective measures will be conducted in densely populated areas or where waste characteristics are such that risks to workers or to the environment are high and special protective measures are needed. Possible factors to consider include health and safety considerations, exposure to hazardous substances, and potential threats associated with treatment, excavation, transportation, and re-disposal or containment of waste material. The short-term impacts of each alternative will be assessed during the evaluation.

4.1.5.4 Implementability

Implementability is often a determining variable in evaluating alternatives. Some technologies will require state or local approvals before construction, which may increase the time necessary to implement the alternative. In some cases, state or local restrictions or concerns may necessitate eliminating or deferring certain technologies or remedial approaches from consideration in alternative selection. The ease or difficulty of implementing each alternative will be assessed by considering the following type of factors:

- Site conditions, land use, and current operations;
- The administrative activities needed to implement the corrective measures alternative (e.g., permits, rights of way, off-site or active work zone approvals) and the length of time these activities will take;
- The constructability/time for implementation and the time required for beneficial results;
- The availability of adequate off-site treatment, storage capacity, disposal services, needed technical services and materials; and
- The availability of prospective technologies for each corrective measures alternative.

4.1.5.5 Cost

The relative cost of an alternative is an appropriate consideration, especially in those situations where several different technical alternatives for remediation will offer equivalent protection of human health and the environment but may vary widely in cost. Cost estimates include costs for site preparation, construction materials, labor, sampling/analysis, waste management, disposal, permitting, health and safety measures, training, Operations and Maintenance (O&M) and system decommissioning/site restoration. These components, as well as other applicable costs, will be used to build a cost estimate for each corrective measures alternative undergoing detailed evaluation. Cost estimates will be obtained from representative subcontractors for the remediation alternatives evaluated. Present worth costs (capital plus O&M) will be estimated to +50/-30 percent.

5.0 Bench-Scale and Pilot-Scale Testing

As part of the CMS, bench-scale and pilot-scale testing may be conducted to support remedial technology selection and design, if applicable. The scope and results of applicable bench-scale and pilot-scale testing will be incorporated into the CMS or a remedial design. The testing may be conducted before, during, and/or following the completion of the CMS. The following testing may be conducted:

- A pilot-scale test may be performed to evaluate in situ groundwater remediation approaches;
- A bench-scale (treatability study) may be conducted to support the design/planning of the in situ pilot-scale test, if it is to be conducted; and
- Pilot-scale testing may also be conducted to support the planning/design of SVE or vapor mitigation systems, if these systems are needed.

If pilot tests are to be conducted, pilot study work plan(s) will be submitted to USEPA for review. The applicable permits will be obtained prior to conducting any pilot studies.

6.0 CMS Reporting, Schedule, and Project Team

6.1 Corrective Measures Study Report Outline and Approach

At the conclusion of evaluation of remedial alternatives, the CMS report will be developed. The results of pilot study (or studies), if performed, will be incorporated into the CMS report or remedial design. The report will follow an outline similar to that listed in **Table 4**. Additional sub-heading components will be added as necessary to explain the technology screening, remedial alternatives assembly and evaluation, and corrective measures recommendations.

The screening and evaluation information, and the recommendations developed will be presented in the report in summary tables that allow the alternatives to be understood. The balance of the report, which will address health risks, environmental effects, cost, and other factors, will be portrayed in tables and discussed in the associated text.

6.2 Project Schedule

The completion of the CMS will require the data that is being presented in the Final Supplemental Remedial Investigation. The CMS schedule assumes:

- Additional Characterization of soil and groundwater will be completed in January and February 2014 and the Draft Supplemental Remedial Investigation will be updated;
- The CMS Work Plan will have been submitted to EPA for review by January 28, 2014, and approved by EPA by March 10, 2014;
- Based on the above, it is expected that the CMS will be submitted to EPA for review by March 24, 2014.

6.3 Project Management and Team

The site-specific purpose of the CMS is discussed in Section 1.3. The project management approach is designed to accomplish the goals and purpose of the CMS. The Project team understands the technical and management strategy for this project and has been working with the regulatory agency personnel to accomplish these goals.

The current facility owner and the responsible party for the Administrative Order for this site is BASF. Dr. Joseph Guarnaccia manages the RCRA Corrective Action activities for the Site. BASF is responsible for the existing environmental conditions at the Site. These environmental conditions include those associated with the Production Area currently included in the Supplemental Remedial Investigation (AECOM, 2012).

BASF has retained AECOM Technical Services, Inc. to manage the environmental conditions related to on-going RCRA activities at the Site. Ms. Joanne Lynch, P.Eng. is the AECOM Project Manager. Dr. Lucas Hellerich, PhD, PE, LEP is the AECOM Project Director for the project. Technical direction is provided by Mr. Malcolm Beeler and Dr. Lucas Hellerich. AECOM prepared this CMS Work Plan, and will be conducting the CMS and preparing the CMS report for submittal for regulatory review and approval.

The US EPA Project Manager for this site is Mr. Frank Battaglia.

7.0 References

AECOM, Sediment IRM, 2012.

AECOM. Supplemental Remedial Investigation. 2012.

Ciba Corporation. RCRA Facility Investigation Phase I Report. 1991.

Ciba-Giegy Corporation. RCRA Facility Investigation Phase II Report, On-Site Areas. 1995.

Ciba-Giegy Corporation. RCRA Facility Investigation Phase II Report, Pawtuxet River Area. 1996.

Woodward-Clyde. On-Site Corrective Measures Study. 1995.

Woodward-Clyde. On-Site Soil Interim Remedial Measures Study. 1996.

Woodward-Clyde, Pawtuxet River Corrective Measures Study, 1996.

Woodward-Clyde, Sediment IRM for the Pawtuxet River, 1996.

Table 1

Table 1
Key Reference Documents that Support Development of the CMS
Corrective Measures Study Workplan

Document	Author	Date	Area Addressed	Purpose/Content
Phase I RCRA Facility Investigation (RFI) Interim Report	Ciba-Geigy Corporation	1991	Production and WWTA	Phase I RI, compile/review historical information
Stabilization Investigation Report and Design Concepts Proposal	Ciba-Geigy Corporation	1993	Production	Describes VOC in soil characterization and soil vapor extraction remedial action.
Phase II RFI	Ciba Corporation	1995	Production and WWTA	Phase II RI and risk evaluation, soil and groundwater characterization field work and assessment of observed impacts on human health and ecological risk
On-Site Corrective Measures Study	Woodward-Clyde	1995	Production	Presents soil and groundwater characterization and remedial alternative evaluation.
Pawtuxet River Corrective Measures Study	Woodward-Clyde	1996	Pawtuxet River (and Groundwater in Production Area)	Presents Pawtuxet River characterization in terms of media impacted sediment, a public health and environmental risk evaluation, development of MPS for Production Area groundwater, and identification and evaluation of corrective measures alternatives that would achieve the MPS.
RFI Report - Pawtuxet River	Ciba Corporation	1996	Production	Phase II RI to characterize river sediment and surface water impacts and assessment of observed impacts on human health and ecological risk
Revised On-Site Soil Interim Remedial Measures (IRM) Report	Woodward-Clyde	1996	Production	Describes PCB in soil characterization, removal and capping
Sediment IRM for the Pawtuxet River	Woodward-Clyde	1996	Production	Describes sediment characterization, excavation and capping in the coffer dam area
Sand Cap Inspection and Sediment Quality Investigation Report for the Pawtuxet River	AECOM	2011	Production	Describes sediment characterization, excavation and capping in the coffer dam area
DRAFT Supplemental Remedial Investigation Report	AECOM	2012	Production	Describes soil and groundwater characterization

Table 2

Table 2
Corrective Action Objectives - Groundwater
Corrective Measures Study Workplan

VOCs (µg/L)	MPS	RIDEM GB Groundwater Objective
Toluene	1,700	1,700
2-Chlorotoluene	1,500	--
1,2-Dichlorobenzene	94	--
Chlorobenzene	1,700	3,200
Total Xylenes	76	--

Notes:

— No GB Groundwater Objective exists

Table 2
Corrective Action Objectives - Soil
Corrective Measures Study Workplan

Compound	MPS	RIDEM Industrial / Commercial Direct Exposure Criterion
Total PCBs	50	10
Non-PCB COCs		As specified in Remediation Regulations

Table 3

Table 3
Screening of Remedial Technologies
Corrective Measures Study Workplan

Technologies Screened	Concerns with Technology	Retained for CMS?
Soil		
No Action	Does not address impacts	Retained only for comparative analysis
Institutional and Engineering Controls		
Environmental Land Use Restriction	Restricts use, does not remove impacts	Retained for further evaluation
Engineered Controls	Physically isolates to reduce human health exposure and/or environmental impacts, but does not remove impacts	Retained for further evaluation
Ex Situ Treatment Technologies		
Excavation and Off-Site Disposal	Technology will address PCBs, but may be cost prohibitive	Retained for further evaluation
Excavation and On-Site Reuse	Technology may be applicable only for lower concentrations of PCBs	Retained for further evaluation
In Situ Treatment Technologies		
In Situ Thermal Destruction	Technology would need to be accepted by Agency and could be cost prohibitive	Not retained for further evaluation
Groundwater		
No Action	Does not address impacts	Retained only for comparative analysis
Institutional and Engineering Controls		
Environmental Land Use Restriction	Restricts use, does not address impacts	Retained for further evaluation
Engineered Controls	Physically isolates to reduce human health exposure and/or environmental impacts, but does not remove impacts	Retained for further evaluation
Monitored Natural Attenuation	Does not treat impacts, monitoring is performed to evaluate potential exposure risks and contaminant reduction	Retained for further evaluation
In Situ Treatment Technologies		
In Situ Chemical Reduction	Applicable to COCs in groundwater, need to distribute amendment properly	Retained for further evaluation
In Situ Chemical Oxidation	Applicable to COCs in groundwater, need to distribute	Retained for further evaluation

Technologies Screened	Concerns with Technology	Retained for CMS?
	amendment properly	
In Situ Enhanced Microbial Reduction	Applicable to COCs in groundwater if used in anaerobic/aerobic step-wise approach, need to distribute amendment properly	Retained for further evaluation
Permeable Reactive Barrier	Applicable to COCs in groundwater, need to distribute amendment properly	Retained for further evaluation
Air Sparge / Soil Vapor Extraction (SVE)	Pilot test of this technology in 2011 indicated that Site was not amenable to successful treatment by SVE	Not retained for further evaluation
Ex Situ Treatment Technologies		
Groundwater Extraction and Treatment	Applicable to COCs in groundwater, but does not destroy COCs and may be cost prohibitive due to extended operation timeframe	Retained for further evaluation

Table 4

Table 4
Proposed CMS Report Outline
Corrective Measures Study Work Plan

1.0 Introduction
- 1.1 Objectives
- 1.2 CMS Approach and Purpose
- 1.3 Report Organization

2.0 Site History and Current Status
- 2.1 Site History
- 2.2 Summary
  - 2.2.1 Overview of Remediation Regulations
  - 2.2.2 Status of Soil/Groundwater Areas
  - 2.2.3 Status of Sediment Areas

3.0 Corrective Measures Objectives
- 3.1 Media Specific Cleanup Standards
  - 3.1.1 Soil
  - 3.1.2 Groundwater
  - 3.1.3 Sediment
- 3.2 Compliance Points
  - 3.2.1 Soil
  - 3.2.2 Groundwater
  - 3.2.3 Sediment
- 3.3 Area and Volume Estimation of Media Requiring Remediation
  - 3.3.1 Area and Volume of Soil Requiring Remediation
  - 3.3.2 Area and Volume of Groundwater Requiring Remediation
  - 3.3.3 Area of Sediment Requiring Monitoring

4.0 Screening of Technologies
- 4.1 Screening Criteria
- 4.2 Soil Technology Screening
- 4.3 Groundwater Technology Screening

5.0 Development and Detailed Analysis of Corrective Measure Alternatives
- 5.1 Corrective Measures Alternatives Development
- 5.2 Detailed Evaluation Criteria
- 5.3 Soil Alternatives Evaluation
- 5.4 Site-Wide Groundwater Alternatives Evaluation
- 5.5 Sediment Monitoring Plan

6.0 Evaluation of a Final Corrective Measure Alternative

7.0 References

Note: Section 4.0 Screening of Technologies will be based on the screening in Table 3 of the CMS Work Plan

Figures

Path: J:\Indl_Service\Project Files\BASF-0760\Cranston RI\7_Deliverables\1. GIS_Database\Projects\Mill_St_WWWTA\Figure_2_Site_Plan.mxd

AECOM 0 45 90 Feet N W E S	FORMER CIBA-GEIGY FACILITY 60297249.1200	FIGURE 2 SITE PLAN
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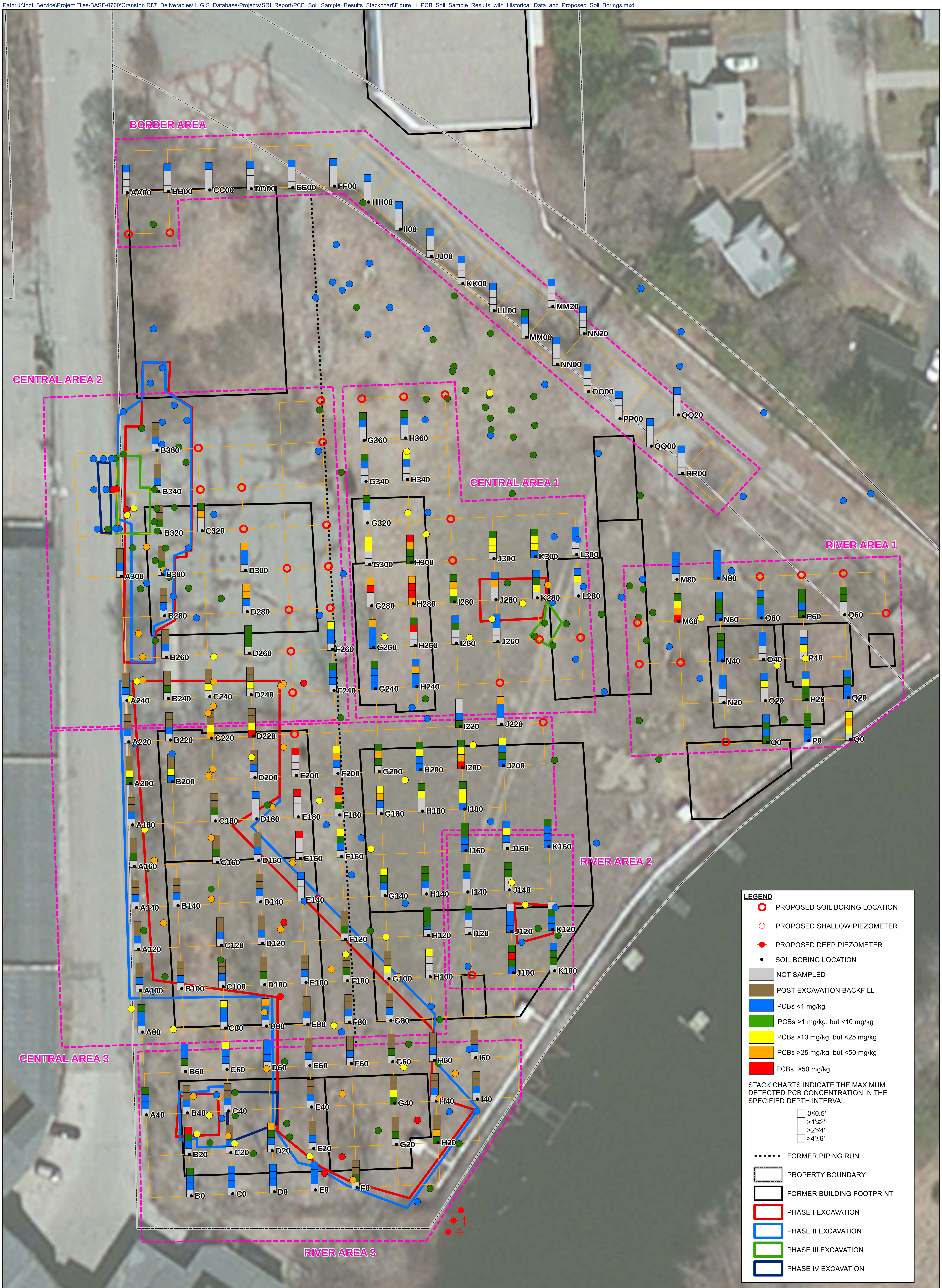

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FORMER CIBA-GEIGY
CRANSTON, RI

60297249.500

DATE: 12/6/2013 | DRAWN: J.E.B

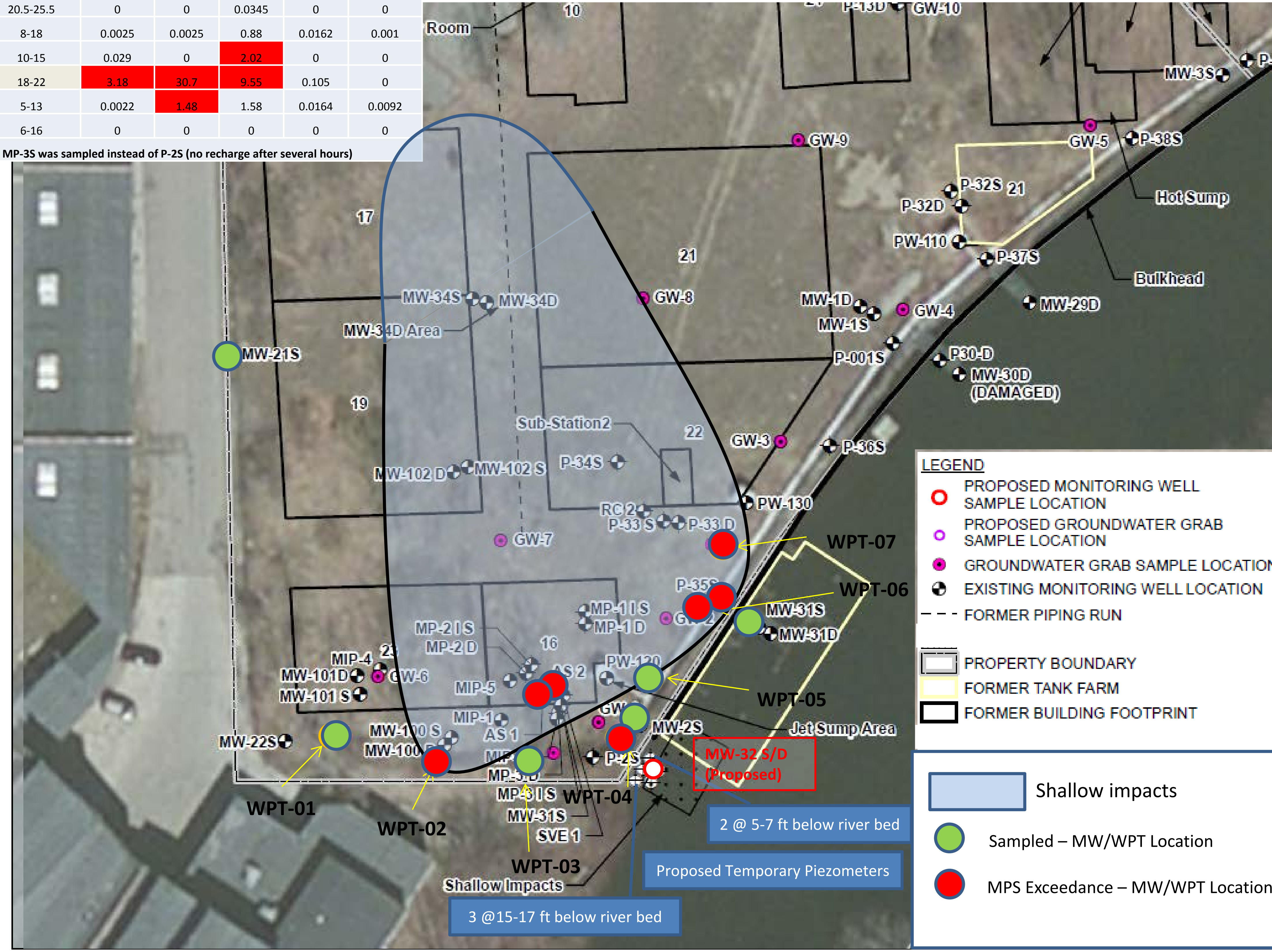
FIGURE 3
PCB SOIL SAMPLE RESULTS WITH HISTORICAL DATA AND PROPOSED SOIL BORINGS AND PIEZOMETERS

Wells		2-ct	1,2-dcb	cb	tol	xyl
MPS (mg/l)	Screen Interval (ft bgs)	1.5	0.094	1.7	1.7	0.07
MW-31S	20.5-25.5	0	0	0.0345	0	0
MW-2S	8-18	0.0025	0.0025	0.88	0.0162	0.001
P-35S	10-15	0.029	0	2.02	0	0
MP-3I	18-22	3.18	30.7	9.55	0.105	0
MP-3S	5-13	0.0022	1.48	1.58	0.0164	0.0092
MW-21S	6-16	0	0	0	0	0

Notes: 0 is ND, MP-3S was sampled instead of P-2S (no recharge after several hours)

Figure 4a: Groundwater Map and Concentrations
Shallow Groundwater

BASF Mill Street Site

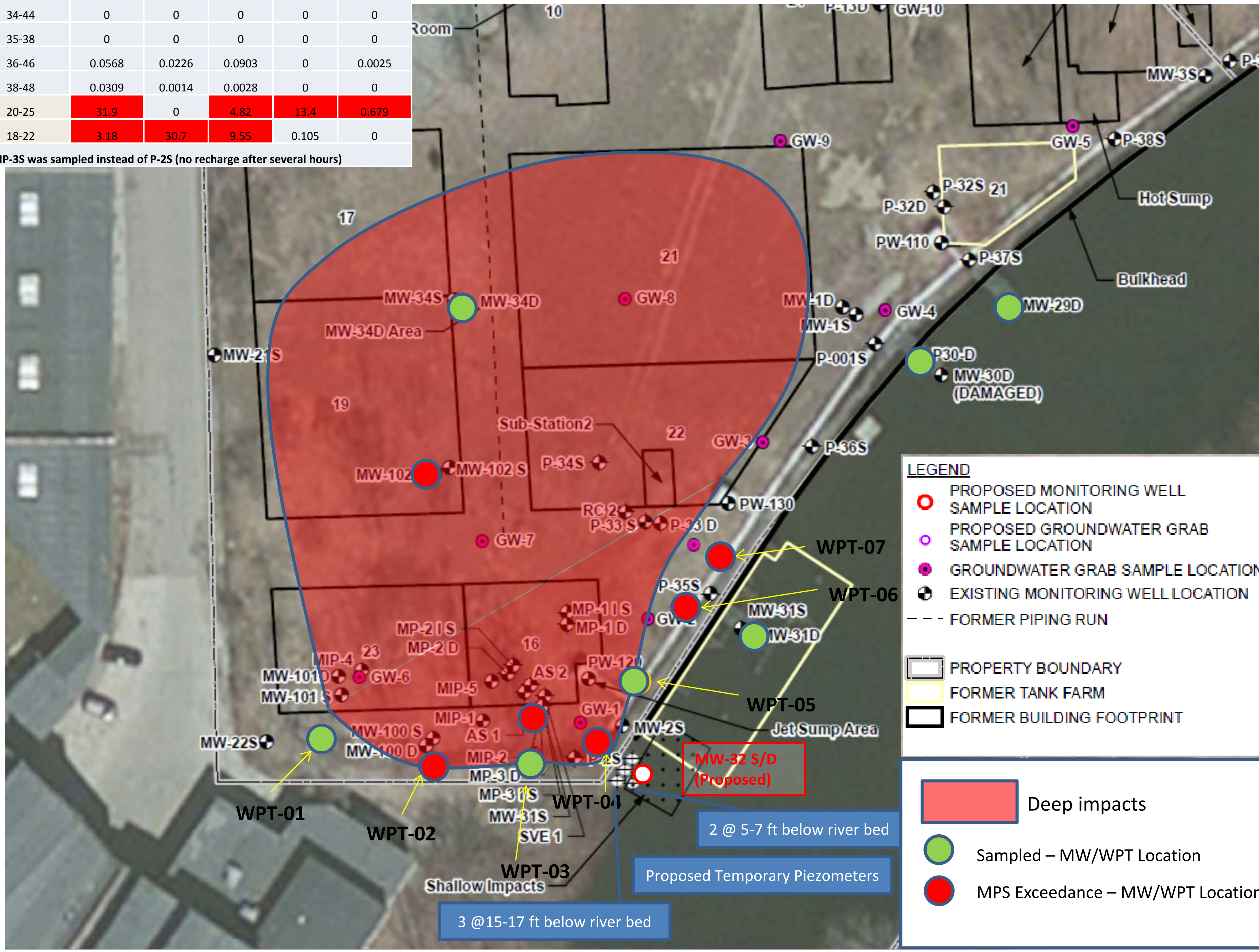


Wells	Screen Interval (ft bgs)	2-ct	1,2-dcb	cb	tol	xyl
MPS (mg/l)		1.5	0.094	1.7	1.7	0.07
MW-29D	34-44	0	0	0	0	0
P-30D	35-38	0	0	0	0	0
MW-31D	36-46	0.0568	0.0226	0.0903	0	0.0025
MW-34D	38-48	0.0309	0.0014	0.0028	0	0
MW-102D	20-25	31.9	0	4.82	13.4	0.679
MP-3I	18-22	3.18	30.7	9.55	0.105	0

Notes: 0 is ND, MP-3S was sampled instead of P-2S (no recharge after several hours)

Figure 4b: Groundwater Map and Concentrations Deep Groundwater

BASF Mill Street Site



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